

WHAT IS CLAIMED IS:

1. A dual feedback control system for maintaining the temperature of an IC-chip near a set-point while said IC-chip dissipates a varying amount of electrical power; said system being comprised of:

5 an evaporator for a liquid refrigerant, and an electric heater which has one face connected to said evaporator and an opposite face for coupling to said IC-chip;

10 an evaporator controller coupled to said evaporator, and a heater controller coupled to said electric heater;

15 said heater controller including a first feedback circuit means for sending electrical power to said electric heater with a variable magnitude that compensates for changes in said IC-chip power; and,

20 said evaporator controller including a second feedback circuit means for passing said liquid refrigerant to said evaporator with a variable flow rate that reduces electrical power usage in said heater over the power usage which occurs if said flow rate is fixed.

2. A dual feedback control system according to claim 1 wherein said electric heater generates heat with quick changes in magnitude in comparison to said evaporator controller which includes a valve that adjusts
5 said flow rate of said liquid refrigerant with substantially slower changes in magnitude.

3. A dual feedback system according to claim 2 wherein said second feedback circuit means senses the instantaneous power to said electric heater, and sends said liquid refrigerant to said evaporator with a flow
5 rate that -a) decreases if the average of the sensed power to said electric heater over a certain time interval is above an upper power limit, and b) increases if said average over said time interval is below a lower power limit.

4. A dual feedback system according to claim 3 wherein said upper power limit is at least twice said lower power limit.

5. A dual feedback system according to claim 2 wherein said second feedback circuit means senses the instantaneous power to said electric heater, and sends said liquid refrigerant to said evaporator with a flow
5 rate that -a) decreases if the average of the sensed power to said electric heater over a certain time interval is above a particular power limit, and b) increases if said average over said time interval is below said particular power limit.

6. A dual feedback control system according to claim 2 wherein said second feedback circuit means senses the temperature of said evaporator, and sends said liquid refrigerant to said evaporator with a flow rate that -a) decreases if said set-point minus the temperature of said evaporator is more than a maximum difference, and b) increases if said set-point minus the temperature of said evaporator is less than a minimum difference.

7. A dual feedback control system according to claim 6 wherein said second feedback circuit keeps said evaporator 30°C to 50°C colder than the temperature of said IC-chip.

8. A dual feedback control system according to claim 2 wherein said second feedback circuit means senses the temperature of said evaporator, and sends said liquid refrigerant to said evaporator with a flow rate that -a) decreases if said set-point minus the temperature of said evaporator is more than a particular difference, and b) increases if said set-point minus the temperature of said evaporator is less than said particular difference.

9. A dual feedback control system according to claim 2 wherein said first feedback circuit means reads the temperature of said IC-chip from a sensor in said IC-chip, and sends electrical power to said electric heater with a magnitude that -a) increases as the temperature of

said IC-chip decreases below said set-point and b) decreases as the temperature of said IC-chip increases above said set-point.

10. A dual feedback control system according to claim 2 wherein said first feedback circuit means estimates the temperature of said IC-chip as a function of the temperature from one sensor on said evaporator and
5 another sensor on said electric heater, and sends electrical power to said electric heater with a magnitude that -a) increases as the temperature of said IC-chip decreases below said set-point and b) decreases as the temperature of said IC-chip increases above said set-
10 point.

11. A dual feedback control system according to claim 2 wherein said evaporator controller includes a programmable member which stores signals that set said upper power limit and said lower power limit.

12. A dual feedback control system according to claim 2 wherein said second feedback circuit determines said average heater power by sensing and filtering the instantaneous power to said electric heater.

13. A dual feedback control system according to claim 2 wherein the combination of said evaporator, said electric heater, said heater controller, and said evaporator controller are replicated in said system
5 multiple times such that each combination maintains the respective temperature of a respective IC-chip near a respective set-point.

14. A dual feedback control system according to claim 2 wherein said evaporator controller opens and closes said valve with a pulse-modulated control signal.

15. A dual feedback control system according to claim 2 wherein said evaporator controller opens and closes said valve to a degree that is selected with the amplitude of an analog control signal.